WATER QUALITY IMPROVEMENT AND CONSERVATION PROJECT

CONCEPTUAL DESIGN

FOR THE

CENTRAL LABORATORY

OF THE

WATER AUTHORITY OF JORDAN

IN THE

MINISTRY OF WATER AND IRRIGATION

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ACRONYMS

A&E	Architecture and Engineering
BOD	Bio-Chemical Oxygen Demand
CL	Central Laboratory
COC	Chain of Custody
COD	Chemical Oxygen Demand
DI	Deionized
DO	Dissolved Oxygen
EC	Electrical Conductivity
Eh	Oxidation-Reduction Potential
GC	Gas Chromatography
GFAA	Graphite Furnace Atomic Absorption
GLP	Good Laboratory Practice
GPC	Gas Proportional Counter
H&S	Health and Safety
HVAC	Heating, Ventilation, and Air Conditioning
ICP	Inductively Coupled Plasma
K-N	Kelfjon Nitrogen
JVAL	Jordan Valley Authority Laboratory
LIMS	Laboratory Information Management System
LSC	Liquid Scintillation Counter
MS	Mass Spectroscopy
MWI	Ministry of Water and Irrigation
O-16	Oxygen-16
PC	Personal Computer
PP	Polypropylene
PVC	Polyvinylchloride
QA/QC	Quality Assurance/Quality Control
RODI	Reverse Osmosis Deionized
S&H	Health and Safety
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TOX	Total Organic Halide
TSS	Total Suspended Solids
TU	Turbidity
USAID	U.S. Agency for International Development
WAJ	Water Authority of Jordan
WQICP	Water Quality Improvement and Conservation Project

A. INTRODUCTION AND BACKGROUND

In September 1994, the Central Laboratory (CL) of the Water Authority of Jordan (WAJ) in the Ministry of Water and Irrigation (MWI) was assessed under U.S. Agency for International Development (USAID) direction for the Water Quality Improvement and Conservation Project (WQICP). One of the most important deficiencies identified during the assessment was the laboratory facility itself. The existing facility lacks sufficient and appropriate space for proper utilization of the equipment. In addition, the lack of space adversely affects the laboratory health and safety (H&S) and quality assurance/quality control (QA/QC) programs. The space issue became a serious obstacle in planning for potential upgrades of the CL. It was suggested that construction of an appropriate new laboratory facility would resolve the existing space issues. A new facility would support upgrading the CL, and would also accommodate future CL expansion plans.

The conceptual design task for the CL was approved on April 11, 1995. The SAIC/DAI concurrence memorandum dated June 28, 1995, which clarified the schedule and scope of work for this task, was approved on July 23, 1995. It was agreed that conceptual design task would be limited to providing a schematic design that would serve as a guide to subsequent detailed design by a qualified architecture and engineering (A&E) vendor.

This report includes two conceptual designs option for a laboratory facility:

- Design A, focusing on the construction of a new CL facility, and
- Design B, focusing on consolidation of the CL and the Jordan Valley Authority Laboratory (JVAL).

Both designs are nearly identical (see Attachment A), except one unit (a non-aqueous sample preparation room) has been added to Design B to accommodate the grinding and preparation of soil and plant samples.

Section B of this report identifies the objectives upon which the two conceptual design options are based.

Section C describes and discusses the rationale for the conceptual design of a new facility for the CL. It also describes the function of each room or laboratory and presents justifications for the proposed arrangements.

Section D outlines the advantages of consolidating the CL and JVAL.

Section E provides information on additional issues and recommendations.

Section F provides a brief synopsis of the conceptual design and draws general conclusions.

Section G includes Attachment A, which incorporates two schematic diagrams of conceptual designs for a new laboratory facility. Design A is the schematic diagram of a proposed new CL, and Design B represents consolidation of the CL and JVAL. Attachment A also includes two tables, 1 and 2, stating the estimated size of each room.

B. OBJECTIVES

In designing a laboratory facility, soundness, utility, safety, and aesthetics are four principal elements to be considered. This conceptual design focuses on enhancing the utility, or function, of a building where scientific laboratory work is conducted. This conceptual design provides usable space for laboratories, laboratory support areas, offices, and interactive spaces for formal and informal gatherings. It is designed to provide a safe and humane workplace environment.

This conceptual design provides information to assist the MWI in answering the following questions:

- What is the mission of the CL?
- What are the goals of the CL?
- How should CL staff achieve these goals?
- What is the desired image for the facility?
- What are the identified constraints?

Other objectives may also include the desire to enhance group interaction, the need for the project to express a positive image to the community, and/or enhancement of the user's recruiting efforts.

One of the most important features of successful laboratory design is the logical placement of various laboratory components. To maximize efficiency, each laboratory component must be placed according to the flow path for the process, namely the sample flow. Additionally, various other characteristic parameters must be taken into account in the internal placement of various laboratory functions (e.g., sample management, check-in, and preparation, avoidance of contamination by sample processing, etc.), and the effects that such placement might have on adjacent functions. For example, acid digestion of soil samples could have an adverse effect on pH measurements of ground water samples if these two functions were not sufficiently separated.

Functional relationships in a scientific environment are primarily determined by factors such as safety, work flow, shared services, and staff interaction. Several key components should be considered in facility design, including:

- Laboratory work-stations

- Support spaces
- Mechanical service space
- Daylight contribution
- Critical environmental concern, e.g., vibration, air pressure, humidity, etc.
- Location of safety equipment, e.g., eyewash stations, fire extinguishers, etc.
- Hallway width (safety concerns, equipment moving)
- Heating, ventilation, and air conditioning (HVAC), exhaust systems, hoods, etc.
- Laboratory islands (workspaces)
- Work and bench space in each laboratory
- Electrical systems classification

The facility will require an HVAC system with separate thermostats in counting rooms, organic instrument rooms, and inorganic instrument rooms. It is strongly recommended that the new facility have a generator as a backup in case of power failure. This will help prevent loss of instrument accuracy, as some instruments (e.g., gas proportional counters and alpha spectrometers) lose their calibration in power failures. Together, these features will meet the objective of producing quality, defensible data.

C. RATIONALE FOR THE CONCEPTUAL DESIGN OF A NEW CL FACILITY/DESCRIPTION OF THE DESIGN

The discussion of the conceptual design will primarily focus on description of Design A, the new facility for the CL. Since one extra sample preparation room is all that would be required to successfully consolidate the CL and JVAL, the description found here is applicable to the recommended consolidation. The additional sample preparation room is described fully in Section D (Advantages Of CL And JVAL Consolidation).

The conceptual design is based on an area of 150 by 110 feet. This is the minimum recommended square footage for the proposed facility. 200 by 150 feet of area would be considered more appropriate for the proposed facility, but area issues depend on MWI land ownership and availability of appropriate land. Other variables to be considered for total facility area include number of employees and square footage required per employee, and size and number of laboratory instruments.

The schematic diagrams included in Attachment A are non-proportional and not to scale. These diagrams are provided to illustrate a basic layout. The conceptual design will require modification and refinement by a professional A&E contractor. When the lot size is finalized, a few additional rooms (laboratories) may be added for possible future expansion of the radiochemistry division.

Table 1 in Appendix A provides estimates of room size based on the estimated 150 by 110 foot area. The numbers provided in the table reflect useable floor space only, and do not reflect structural space occupied by walls, crawlspaces, ducts, columns, etc.

It is important to note that at the time of facility construction, the location of computer cables and phone wiring should be determined. These issues are beyond the scope of this task, and should be discussed in the detailed facility design (see Section E).

The designs submitted are single-level laboratory arrangements. Construction on a single level is recommended to increase the safety of the laboratory facility. The advantages of having a single-level structure are as follows:

- It is easier to evacuate in case of emergency,
- Individual areas are easier to seal to avoid contamination spread,
- A single-level exhaust/ventilation system helps reduce the risk of cross-contamination, and
- A single-level exhaust/ventilation system helps ensure employee safety by minimizing internal air pollution.

The overall laboratory building design incorporates two distinctly different sections of the laboratory:

1. An exterior shell with some rooms designated as offices (with external picture windows), and
2. An interior section housing most of the laboratories (with picture windows to the surrounding hallways).

The proposed conceptual design of the laboratory facility is composed of three distinct areas. These areas will be discussed in terms of their corridor designation, as follows:

- Corridor A - "Clean Area" containing offices, computer rooms, reception, a conference room/library, etc. Wearing laboratory coats in this area is prohibited in order to prevent potential cross-contamination within the laboratory facility.
- Corridor B - Radiation Control Area containing a radiochemistry laboratory and equipment, counting rooms, etc.

- Corridor C - Chemical Control Area containing organic and inorganic chemistry suites, a microbiology laboratory, etc.

A clear width of 6 to 8 feet is common for American laboratory corridors where tanks, equipment, and carts must travel. However, since Corridor A will primarily serve as a personnel passageway, its width can be reduced to 4 or 5 feet. Such a narrow width is a good idea, as it will inhibit the potential for placing refrigerators or storage items in the corridor. The above widths represent commonplace American standards, and should be adjusted to complement Jordanian requirements.

It appears that the most logical way to approach laboratory design is to follow the particular CL process function.

Whenever possible, all interior laboratories will have large picture windows facing the hallways. This feature has several important advantages. First and most important, it provides a means for safety observation of laboratory personnel. Secondly, visitors can readily observe the work being done in the laboratories without disrupting the work flow. Thirdly, such picture windows provide an inconspicuous means for overseeing the work process in the laboratory.

To simplify discussion of the proposed design, the attached provisional diagrams (Attachment A) will be discussed in a North-South orientation, with the southernmost points being the main entrance at the bottom of the attached pages.

C.1 - Corridor A

Corridor A is considered the "clean area" of the proposed laboratory facility. This area will provide office space for the Laboratory Directorate and supervisors, a conference room/library, a reception area, and rooms dedicated to computer staff and standard office equipment (copiers, faxes, etc.).

As the attached provisional diagrams illustrate, one corner of the proposed building's outer shell is occupied by sample receiving (in Corridor C), while its diagonal opposite in Corridor A is intended for the Laboratory Directorate (see Office #6, below). This placement helps emphasize the separation of office staff from laboratory activities.

Adjacent to the reception/telephone operator area, moving eastward along Corridor A are:

- **Receptionist/Telephone Operator Area:**
  At the main entrance to the laboratory facility, a reception area is needed. This area can house the main telephone console and provide adequate workspace for a professional receptionist or secretary. The reception area

can be built as an "L"-shaped unit, if desired, or as a small room with a glass half-wall.

One full-time employee is required to handle light secretarial duties and act as receptionist/ telephone operator. To provide security and safety measures, all visitors must be signed in and out through this area. The laboratory's principal fax machine should be set in this area, close to the receptionist, where incoming and outgoing faxes can be monitored.

- **Suite of Offices (Offices 1 through 9):**
  Office #6 is designated for the Laboratory Directorate. This office is larger and adjacent to the conference room. The placement of the Directorate's office is crucially important. It enables ready access to key personnel and supervisors, the primary entrance, and the reception area, enabling guests and dignitaries to be expeditiously escorted to the Directorate.

  Offices 1 through 5 and 7 through 9 are located on both sides of the Directorate's office and can serve the needs of additional supervisory or managerial staff, and may be utilized by visiting professionals (if necessary).

  Offices 1 through 6 have pictured windows to the outside. These windows will be equipped with blinds to filter/eliminate external light if the occupant desires.

- **Conference Room/Library:**
  A shared meeting space with good audio/visual equipment is of particular interest in a scientific society where idea stimulation is a prime goal of the workplace.

  The conference room will include shelves around the room to accommodate books and various journals. A conference table and chairs will help facilitate productive meetings and study. This room also can serve as an internal training room.

  This room will be built with two doors. The one towards the offices should be closed at all times except in cases of emergency. The main entrance to this room is located in Corridor A.

- **Group Tea Room/Lunch Room/Break Room:**
  By far the most important amenity to provide the laboratory staff is the group tea room, lunch room, or break room. Since, food, drink, and smoking are prohibited in the laboratory, a break area located just outside of the laboratory meets a real need. Restrooms for male and female personnel are adjacent to this room.

  Private lockers can be installed in this room so each employee will have a secure storage area for personal effects or material not permitted in the laboratory. This room may also be utilized for facilitation of informal gatherings such as conversations and small group discussions.

- **Copy/Office Supply/Fax Room:**
  The preparation of reports, proposals, journal articles, and routine laboratory documentation requires paperwork generation. The laboratory would be well-served by a centrally located shared facility for copying, supply storage, and possibly additional fax machines. Locating this room adjacent to the manager, supervisors, and the reception desk along the main circulation spine will help encourage staff interaction and idea exchange.

  A locking cabinet should be set in this room for the storage of office supplies (e.g., pens, computer disks, pads, etc.).

- **Computer Room:**
  The main computer, along with several personal computers and printers and associated equipment will be located in this room. The room is intended for entry of laboratory data, report generation, etc.

  File cabinets may be located in this room for record keeping of commercial contracts, memos, orders, and current project paperwork.

- **Record-Keeping/Archive Room:**
  Located across from the Computer Room, this room is intended for long-term archiving of laboratory records. The records will be stored in fireproof files.

- **Custodial Storage Room:**
  This room can serve as storage for custodial and janitorial equipment. The room should be equipped with standard housekeeping equipment (brooms, cleansers, floor wax, etc.) and a large sink.

- **Restrooms:**
  Separate restrooms for male and female personnel will be located next to the custodial storage room.

- **Utility Room:**
  At this point, the utility room has been designed to be attached to the restrooms, at the far northeastern end of Corridor A. Depending on the architectural design and requirements, this room may be relocated.

  Central building systems equipment, e.g., backup air units, standby or backup generators, compressed air supplies, vacuum pumps, etc., should be located in this room and distributed vertically through the service shafts. Additionally, the fire suppression system and sprinkler controls may be located in this room.

C.2 - Corridor B

Corridor B will be a radiation-controlled area. The entrances/exits to this hallway from Corridors A and C are to be equipped with radiation monitoring equipment. All samples containing radiation must be processed within the confines of Corridor B.

This corridor will be closed off and monitored by two doors with cipher locks. Personnel entering or exiting Corridor B should monitor himself/herself with a Geiger counter. This action is intended to ensure the occupational safety of the laboratory environment by preventing radiological cross- contamination. Laboratory staff working in Corridor B must wear laboratory coats, goggles, and a film badge at all times (Counting Room staff will not need to wear goggles). Visitors entering this area will be required to carry a dosimeter. Smoking, drinking, and eating in this area will be prohibited.

Corridor B will house along the exterior wall the following laboratories:

- **Counting Rooms 1 and 2:**
  Counting rooms are instrument rooms for radiochemical analyses. Liquid Scintillation Counters (LSCs), Gas Proportional Counters (GPCs), and alpha spectrometers ($\propto$-spects.) are the instruments that will be installed in this room. Gamma Spectroscopy (γ-spects) and X-ray spectroscopy may be two future areas of expansion for this department.

  Counting Room 1, the larger of the two rooms, has been designed for LSC, GPC, and γ-spectroscopy measurements. Counting Room 2, although smaller in size, will be suitable for $\propto$-spectroscopy measurements.

Counting Room 1 has a single door, a half-door from Corridor B, and a double door towards the outside. This double door will only be used for transporting the instruments in the counting rooms. This door should be locked at all times after the laboratory is set up. This door should be connected to an emergency alarm system, and will be used as an emergency exit. Apart from the emergency exit bar usually found on such doors, the door should be locked and the key kept by Laboratory Directorate and/or his alternate.

Counting Room 2 is connected to the Counting Room 1 by a single or double door. Both rooms have picture windows, as shown in the diagrams (Designs A and B).

To ensure accurate, reliable, and defensible measurements, the background radiation in these rooms should be monitored at all times, or weekly at a minimum. Accordingly, all instrumentation must be fully calibrated at all times in order to ensure data quality.

- **Office #10:**
  This office can be designated for the use of the future H&S/Radiation Protection Officer. Since this position is not a full-time job at present, and the number of radiochemical samples analyzed per week is not at maximum capacity, both responsibilities can be handled by one person.

  This office could also be used for storage of calibration instruments such as oscilloscopes, ohmmeters, etc.

- **Radiochemical Sample Preparation Laboratory:**
  Samples for radiochemical analyses (e.g., carbon-14 for LSC, gross alpha/gross beta for GPC, and uranium isotopes for alpha spectroscopy) will be prepared in this laboratory. These sample preparation processes may include distillation, ion-exchange, extraction, filtration, etc. Prepared samples will be delivered to the counting room from the "half-door/window" for counting measurements.

- **Standard Preparation/Reference Source Storage Room:**
  This room serves as a sample distribution area for various radiochemical analyses, QC samples, and standard preparation.

  A locking cabinet should be placed in this room to store the radioactive sources and standards.

This room will require a sink, hood, and some bench space. The exact specifications of the interior of this room are beyond the scope of this task under the WQIC Project.

- **Oxygen-16 (O-16) Sample Laboratory:**
  This laboratory is composed of two rooms. The entrance is to a larger room, which is dedicated to sample preparation. This room is connected to a smaller room, designed as an instrument room for O-16. The instrument room has a picture window for safety purposes. Staff in the sample preparation laboratory will be able to monitor the instrument room while preparing the samples.

C.3 - Corridor C

All personnel working in Corridor C must wear laboratory coats and goggles at all times. Smoking, drinking, and eating in this area should be prohibited.

General Sample Receiving and Storage Issues:

Typically, all samples arrive in one location, the shipping and receiving facility, which is generally located at the corner of the laboratory building, and has loading dock access. Upon arrival, the samples are pre-screened for acceptability and logged into a Laboratory Information Management System (LIMS) for sample tracking. The LIMS is involved in the tracking of sample processing progress and in quality assurance (QA) functions. The initial pre-screening involves physical inspection of samples, e.g., evidence of sample spilling or contamination in shipment, evidence of precipitation in liquid samples.

At the time of receipt, all samples are screened for the presence of radiation. Samples with radioactive components must be handled within the laboratory's radiation-controlled section.

All liquid samples are checked on arrival for correct preservation. This involves checking the sample pH and performing a visual inspection for signs of precipitation. The arriving samples usually have an accompanying Chain-of-Custody (COC) form with the recorded sample history, including field tests results (pH, temperature, EC, Eh, etc.).

In the laboratory's receiving section, the sample receiving personnel, after evaluation of the arriving sample, the accompanying COC papers, and in some cases the additional instructions, should enter all relevant information into a computer. In this way, each sample will have a specific chronological identification number, simplifying sampling tracking. At this point, a sample pathway decision must be made. Some samples (e.g., designated for analysis of semi-volatile organics) need to be put into the analytical processing stream as soon as possible, because they have a relatively short allowable holding time. Accordingly, samples such as soils designated for metal analysis have a rather long holding time (e.g., six months), and can be put into storage for less accelerated processing and analysis.

It is a good laboratory practice (GLP) to store all samples in temperature- and access-controlled room. The room environment is subjected to continual monitoring (e.g., temperature and continuing temperature record displayed at the room entrance). All samples containing volatile and semi-volatile components should be stored separately from those samples that do not contain these migratory components. It is the best practice to store each class of samples (volatile, semi-volatile, etc.) in a separate environmentally controlled locker or refrigerator.

Along the facility's exterior wall, Corridor C will house the following:

- **Downloading/Sample Receiving Area:**
  Please see above for an overview of sample receiving/logging information. Gas tanks with wall hitches to prevent toppling should be stored in this area.

- **Office # 11:**
  This office is intended for the sample receiving personnel. This office will require a personal computer (PC) terminal to log in information related to new samples, such as entering requested analyses on each sample, providing a specific identification number, providing COC information for the laboratory staff and supervisors, etc.

- **Supply Room:**
  This room is designated for storage of laboratory supplies (e.g., glassware, paper towels, pipets, etc.). This area must be kept clean and organized at all times.

- **Reagent/Standard Preparation Room:**
  In order to prevent any contamination or cross- contamination of reagents and standards, this room is dedicated to preparation of standards and reagents. Since all standards and reagents must be prepared with deionized (DI) water, this room is the most suitable room for installation of a new DI water system. Portable DI-Water jars can be located throughout the laboratory.

- **Sample Storage Room:**
  This room serves as a sample storage and distribution room.

After samples are logged into the computer, the samples and their binders, each including a copy of all information necessary for analyses, will be delivered to this room. The laboratory staff member responsible for this room will divide the samples in appropriate different volumes for the required analyses. All work should be documented in the appropriate binder/folder.

The supervisors should be responsible for direct contact with the sample distributor in order to be aware of the arrival of any new sample for analyses.

- **Physical Test Laboratory:**
  This room will be used to measure physical properties of the samples, such as pH, Eh, Ec, turbidity (TU), taste, odor, color, temperature, etc. These measurements are currently performed redundantly at different parts of the CL. Concentrating all physical measurements in this room will save money by reducing the waste of chemicals and time, and will prevent result discrepancy based on data generated.

- **Wet Inorganic Chemistry/Aqueous Sample (Water and Wastewater) Preparation Laboratory:**
  This room is designed to be used for sample preparation of water and wastewater samples, digestion, etc. This laboratory would require an island incorporating different types of utilities (to be discussed in the detailed design of the facility). This room will be used for simple analyses such as titration for determination of various anions and cations, biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), total dissolved solid (TDS), total suspended solid (TSS), etc.

- **Laboratory-Derived Waste Storage Room:**
  This room is designed as a secure storage area for wastes generated as a result of laboratory experiments. The waste can be packaged and stored according to Jordanian protocols, and shipped directly from this room using locked door and a small loading dock on the room's outside wall.

  All electrical devices in this storage room should be explosion-proof, and a portable fire extinguisher should be mounted on the wall adjacent to the entrance.

  In general, the laboratory-derived waste can be in three categories:

1. Chemical wastes -
   A dedicated space near the loading dock will be designated to collect and store chemical wastes in preparation for disposal. This room should not be below grade because of the explosion potential. This room will be designed to be adjacent to the outer shell (wall) of the building, will have an outside door, and should contain "blow-out" panels in a surface-to-volume ratio of at least one square foot to 40 cubic feet of room volume. Exhaust ventilation requirements will be at least 10 air changes per hour to purge any fumes from spills or leakage. If incompatible chemicals are stored in this room, a physical barrier will be used to subdivide the room.

2. Liquid wastes -
   Liquid wastes, along with pathogenic, toxic, and/or acidic liquid wastes require a special piping system, as do storage and treatment facilities for such wastes. Special systems installed in the proposed facility may include a central building dilution tank with automatic monitoring capability. This tank would automatically measure the pH of liquids and add caustics or acids as necessary to neutralize the liquids before their entry into the sanitary sewer system.

   It may be necessary to establish a policy for the laboratory personnel to place such wastes in reusable containers that are periodically disposed of off-site in a manner consistent with Jordanian regulations and sound environmental practice.

3. Radioactive wastes -
   Radioactive waste materials must be carefully monitored for appropriate disposal. Facilities that generate radioactive waste require a dedicated, shielded room (similar to the chemical storage room) near the shipping dock. Monitoring of the air and exhaust system (where radiation concentrations are expected to exceed certain predetermined levels) in this room must be continuous.

   It is important that the building design provide easy and convenient access to monitoring devices throughout the facility.

While this room is intended for storage as described above, it is strongly recommended that the dilution tank, as described under liquid waste, be installed.

Please note that the above-mentioned standards/references are based on commonplace American practices, and should be adjusted to meet Jordanian requirements.

- **Microbiology Laboratory:**
  This laboratory a two-room unit. The larger of the two rooms is designed for sample preparation, and will require an island with appropriate utility connections. This room is connected to a smaller instrument room used for microscopy and other analyses. The smaller room will have a picture window for easy monitoring of the room. This laboratory will require a separate ventilation/exhaust system and thermostat to control the laboratory temperature.

The following are found across from the above-mentioned facilities, on the southern side of Corridor C:

- **Organic Chemistry Laboratory:**
  This section includes three rooms:

  1. Sample preparation, which would hold Kelfjon-Nitrogen (K-N), total organic carbon (TOC), and total organic halide (TOX) instruments.

  2. Gas Chromatography (GC) Room for organic analyses. This room requires separate, independent ventilation and exhaust systems.

  3. Gas Chromatography/Mass Spectrometry (GC/MS) Room for volatile and semi-volatile analyses. This room requires separate, independent ventilation and exhaust systems.

The interior laboratories located between Corridors A, B, and C are slated to become three organic analytical laboratories. Two of the rooms will be devoted to volatile and semi-volatile measurements by GC and MS.

- **Chemical Storage Room:**
  The Chemical Storage Room is centrally located within the laboratory for easy access. This room will require solid-front cabinets for chemicals.

This room will also require one refrigerator for chemicals and solutions requiring storage in a cold temperature. The explosive-proof cabinet can also be stored in this room.

- **Balance Room:**
  The Balance Room is also centrally located within the laboratory for easy access. This room would require small, solid benches for the balances in order to prevent any movement that could potentially affect balance calibration.

- **Glass Washing Room:**
  Autoclaves, glass-washing machines, dryers, and electric steam generators (if applicable) should be located in this room. This room requires a seamless, waterproof floor within the equipment zone, floor drainage, a stainless steel sink, and hot and cold water plumbing.

- **Instrument Rooms #1 and #2:**
  Equipment that generates noise and high levels of heat should be somewhat isolated from the laboratory work space, yet be conveniently located. This room may require special design considerations due to the variety and density of electric power that may be needed, depending on the instruments installed in the room. In general, a typical 10-by-20 foot equipment room will have 13 power outlets mounted at 48 inches above the floor, with 11 circuits as follows:

  - 5 - 115 vac, 20 amp duplex outlets on 3 circuits
  - 1 - 208 vac, 20 amp, 3-phase circuit
  - 3 - 208 vac, 20 amp, single-phase circuit
  - 4 - 208 vac, 30 amp, single-phase circuit

  Please note that the above-mentioned voltage requirements are based on standard American laboratory requirements. Jordanian electrical and voltage requirements are different, and should be addressed by the A&E contractor.

Interior laboratories in Corridor C will be dedicated to Graphite Furnace Atomic Absorption (GFAA), Inductively Coupled Plasma (ICP), Flame Photometer, UV-Vis, and Cold Vapor Mercury Analyzers. These inorganic analytical laboratories, as with the organic laboratories, will have picture windows facing the hallway.

D. ADVANTAGES OF CL AND JVAL CONSOLIDATION

Design B (see Attachment A) is provided to illustrate consolidation of the JVAL and the CL. The only additional design requirement for this consolidation is the addition of one room for sample preparation of non-aqueous samples such as soil, plants, agricultural products, etc. The remainder of the laboratory facility's rooms can be shared by the consolidated entities.

D.1 Potential Benefits of Consolidation

- Consolidation will allow more emphasis on interdisciplinary stimulation and open communication of ideas.

- Controlling the laboratory environment and providing reliable utility services has become the highest priority of laboratory directors. By consolidating CL and JVAL activities, MWI will be able to concentrate on this issue more efficiently.

- Consolidation provides considerable cost savings to MWI. Operation and management of one analytical apparatus will greatly increase the cost-effectiveness of MWI laboratory operations.

- Laboratory equipment requirements are becoming more demanding. Accordingly, capital costs related to equipping the modern laboratory have increased. By consolidating the two laboratories, much of the equipment can be shared, effectively reducing costs.

- The correlational relationship between CL data regarding water and wastewater monitoring and JVAL data regarding irrigated soil monitoring would be easily tested qualitatively analyzed.

- Consolidation would enable one Directorate to provide primary supervision of the Laboratories. The Laboratories would share comprehensive QA/QC and H&S programs, thus requiring only one manager for each program. Cross-training of laboratory personnel would improve analytical and administrative efficiency.

D.2 Additional Rooms Required for Consolidation

- **Non-Aqueous Sample (Soil and Plant) Preparation Laboratory:** This laboratory will consist of two rooms. The smaller room will be connected to the larger room, and will have no outlet to the hallway (Corridor C). This elimination of access to Corridor C is because this room may be used for soil grinding, a process that creates considerable amounts of dust. This dust represents a potential source of contamination if it is not separated from the sample preparation room. This room will have picture windows facing the larger sample preparation room and Corridor C.

The larger room is designed for sample preparation of non-aqueous samples, which require leaching, extraction, and/or digestion.

After samples are prepared, they can be forwarded to the appropriate instrument room(s) for measurement/analysis.

E. ADDITIONAL ISSUES AND RECOMMENDATIONS

In general, the interior of all sections of this conceptual design should be addressed in the next stage (detailed design). The proposed Statement of Work (SOW) for detailed design of the facility was submitted in April, 1995 and is pending the approval of USAID.

Issues to be addressed in the detailed design stage include, but are not be limited to:

E.1 Communications and Computer Equipment

- **Electrical Outlets, Computer Cables, and Telephone Jacks:**
  The building should have a backup generator to be used in cases of emergency and power failure.

  Some rooms may require specific and dedicated outlets (e.g., copy room and computer room) and amperage. These issues will be identified in the detailed design phase.

  Each office will require a phone jack, a computer jack, and at least two electrical outlets. An intercom system throughout the laboratory facility should also be considered. Communication, both electronic and verbal, is essential in the modern laboratory environment.

  These issues are beyond the scope of this task under the WQIC Project, and will be identified in the detailed design of the laboratory.

- **Audio/Video Equipment**
  The detailed design of the proposed laboratory facility should address the feasibility and necessity of video/audio equipment for training purposes, based on the preferences expressed by the MWI.

E.2 Work Spaces/Cabinets and Carpentry

- **Laboratory Work and Bench Space, Drawers, and Wall Cabinets:**
  Almost all rooms will require some bench space with drawers and wall-mounted cabinets.

  The specification of work space is beyond the scope of this task under the WQIC Project, and will be addressed in the detailed design of the laboratory.

- **Wall Coverings:**
  Issues related to paints and wall coverings are beyond the scope of this task under the WQIC Project, and will be addressed in the detailed design of the laboratory facility.

- **Carpentry and Floors:**
  Floor coverings in laboratory areas should be water- and chemical-resistant surfaces. These surfaces should be non-skid and easy to clean. Offices located in Corridor A can be carpeted if desired.

  Issues related to carpentry and floors are beyond the scope of this task under the WQIC Project, and will be addressed in the detailed design of the laboratory facility.

E.3 Ventilation and Safety Systems

- **Ventilation and Exhaust Systems:**
  The facility should have some central systems equipment located at the base and top of the building. Obviously, the fume hood exhausts should exit at the roof, and the fresh air intakes should be well-separated from the contaminated exhaust effluent.

  Fume hood exhausts should rise through the shafts to a fan gallery on the roof where exhaust fans and emissions control equipment can be located.

  It is strongly recommended that the volatile, semi-volatile, and microbiology laboratories have separate vent and exhaust systems. These laboratories require that fresh air intakes be remote from exhaust discharge to prevent any cross-contamination from air recycling.

- **Hoods:**
  Each laboratory will require specific types of hoods based on the activities of that laboratory.

  This issue is beyond the scope of this task under the WQIC Project, and will be addressed in the detailed design stage.

- **Safety Equipment:**
  Locations of safety equipment such as emergency showers, fixed eyewash stations, emergency eyewash outlets, fire blankets, spill kits, "kill" switches, and portable fire extinguishers should be identified before building construction commences.

  These specifications are beyond scope of this task under WQIC Project, and should be addressed in detail design of the facility.

  Sprinkler systems located in Corridor A may be supplied with water-based fire suppressants, while those located in Corridors B and C may need chemical suppressants. The nature of the suppressants used in the laboratory areas will depend on Jordanian laws and potential chemical interactions.

  Further issues relating to sprinklers, smoke detectors, and fire suppression should be addressed in the detailed design of the proposed facility.

E.4 Plumbing, Gas, and Vacuum Systems

- **Sinks and Other Utilities:**
  Some of the laboratories will require islands with different sizes or types of sinks, and various utilities such as air, gas, and electricity. Safety equipment such as showers and eyewash stations will also be required.

  These issues are beyond scope of this task under WQIC Project, and should be addressed in the next stage of the laboratory design.

- **Gas, Vacuum Systems:**
  Natural gas, compressed air, and vacuum outlets are generally utilized for laboratory benches, workspaces, or islands, and are usually distributed from a central system. Other gases are frequently required for specific equipment or processes, but are normally supplied locally from replaceable cylinders such as nitrogen or carbon dioxide.

The handling of gases may require utilization of dedicated distribution systems. Additionally, custom-designed gas cabinets are often required for leak purging, fireproofing, and use monitoring.

The specifications of these issues are beyond the scope of this task under the WQIC Project, and should be addressed in the detailed design phase.

- **Water Supply System:**
  Many plumbing codes require complete separation of the water system serving the laboratories and the system serving the building. This type of water system is usually complemented by a pure water system, such as distilled and deionized water. Some laboratory work may require reverse-osmosis deionized pure water (RODI) systems, salt tanks, and setting chambers. Pure water systems must offer continuous circulation to ensure the water does not become static in the piping system and become subject to contamination.

  It is also important to select the appropriate pipe material for the water system. Common piping materials in laboratories include aluminum, block tin, tin-lined copper, stainless steel, polyvinylchloride (PVC), and polypropylene (PP).

  A detailed discussion of plumbing and piping issues is beyond the scope of this task, and should be addressed in the detailed design stage.

E.5 Security Equipment

Security issues, such as alarm systems, security guards, etc. are beyond the scope of this task and should be addressed in the detailed design of the proposed facility.

F. CONCLUSIONS

The conceptual design for the CL and the design for the potential consolidation of the CL and the JVAL are intended to serve as a starting point for MWI consideration of laboratory upgrades. The provisional designs consider basic space requirements, facility needs, safety and health issues, and the fundamental needs of a modern laboratory facility.

The conceptual designs focus on the creation of a safe, and humane workplace environment. The functions of the laboratory areas are clearly delineated, and the provisional design's separation of radioactive, chemical, and administrative functions should help ensure the development of an efficient professional laboratory. The administrative module (Corridor A) should be able to operate with no impact on the work being performed in the laboratories. Concurrently, the laboratories housed in the secured Corridors B and C can function without adversely impacting each other through inadvertent cross-contamination or space difficulties.

This conceptual design provides the basis for the construction of an efficient scientific environment. The recommendations made here are intended to identify the basic requirements of a modern laboratory. Following the guidelines of the Statement of Work, this report only briefly mentions items that should be discussed and evaluated under the following detailed stage of the laboratory design. Issues such as communications (inter- and intra-laboratory), work spaces, carpentry, ventilation, safety systems, security, and plumbing are beyond the scope of this task. These issues were mentioned in this conceptual design to point out their great importance in the detailed design stage of the laboratory design.

G. ATTACHMENTS

Table 1 describes estimation of the minimum requirement of size for each room in Design A. Table 2 states the estimated size of each room for optional Design B. Note that the sizes are based on useable space and do not in include structural/non-usable space (e.g., wall thickness, ducts, crawlspaces, columns, etc.).

Attachment A also includes two diagrams of the conceptual design, Designs A and B. Design A is the proposed conceptual design for a new CL facility, and Design B is the proposed conceptual design for CL and JVAL consolidation.

ATTACHMENT A

Table 1
(Design A)

LOCATION	ESTIMATED SIZE (Ft)[1]	ESTIMATED AREA (SF)[2]	ESTIMATED SIZE (M)[3]	ESTIMATED AREA (SM)[4]
Corridor A:				
Reception Area	14.0 X 14.0	196	4.5 X 4.5	20.25
Office #1	8.0 X 9.0	72	2.5 X 3.0	7.5
Office #2	8.0 X 9.0	72	2.5 X 3.0	7.5
Office #3	8.0 X 9.0	72	2.5 X 3.0	7.5
Office #4	8.0 X 9.0	72	2.5 X 3.0	7.5
Office #5	8.0 X 9.0	72	2.5 X 3.0	7.5
Office #6	12.0 X 14.0	168	3.5 X 4.5	15.75
Conference Room	20.0 X 11.0	220	6.0 X 3.5	21.0
Office #7	7.0 X 11.0	77	2.0 X 3.5	7.0
Office #8	7.0 X 11.0	77	2.0 X 3.5	7.0
Office #9	7.0 X 11.0	77	2.0 X 3.5	7.0
Group Tea/Lunch Room	20.0 X 11.0	220	6.0 X 3.5	21.0
Copy Room	14.0 X 25.0	350	4.5 X 7.5	33.75
Computer/Staff Room	12.0 X 25.0	300	3.5 X 7.5	26.25
Archive	12.0 X 25.0	144	3.5 X 7.5	26.75
Janitor Room	10.0 X 14.0	140	3.0 X 4.5	13.5
Female Restroom	13.0 X 14.0	182	4.0 X 4.5	18.0
Male Restroom	12.0 X 14.0	168	3.5 X 4.5	15.75
Utility room	10.0 X 14.0	140	3.0 X 4.5	13.5
Corridor B:				
Counting Room #1	36.0 X 25.0	900.0	11.0 X 8.0	88.0
Office #10	8.0 X 9.0	72.0	2.5 X 3.0	7.5
Counting Room #2	22.0 X 25.0	550.0	7.0 X 8.0	56.0
Radiochem. Lab	38.0 X 22.0	836.0	11.5 X 7.0	80.5
Radium Lab	14.0 X 22.0	308.0	4.5 X 7.0	31.5
Rad. Std./QC Room	14.0 X 22.0	308.0	4.5 X 7.0	31.5
O-16 Instrument Room	14.0 X 10.0	140.0	4.5 X 3.0	13.5
O-16 Lab	12.0 X 14.0	168.0	3.5 X 4.5	15.75

Table 1 (*continued*)
(Design A)

LOCATION	ESTIMATED SIZE (Ft)[1]	ESTIMATED AREA (SF)[2]	ESTIMATED SIZE (M)[3]	ESTIMATED AREA (SM)[4]
Corridor C:				
Down Loading	26.0 X 14.0	364.0	8.0 X 4.5	36.0
Office #11	8.0 X 9.0	72.0	2.5 X 3.0	7.5
Supply Room	12.0 X 14.0	168.0	3.5 X 4.5	15.75
Reagent Lab	10.0 X 14.0	140.0	3.0 X 4.5	13.5
Sample Storage Room	10.0 X 14.0	140.0	3.0 X 4.5	15.5
Physical Test Lab	12.0 X 14.0	168.0	3.5 X 4.5	15.75
Wet Chem. Lab	30.0 X 14.0	420.0	9.0 X 4.5	40.5
Waste Storage Room	14.0 X 14.0	196.0	4.5 X 4.5	20.25
Microbio. Instrument	14.0 X 8.0	112.0	4.5 X 2.5	11.25
Microbiology Lab	27.0 X 14.0	378.0	8.0 X 4.5	36.0
Inorg. Instrument #1	22.0 X 50.0	1100.0	7.0 X 15.5	108.5
Inorg. Instrument #2	22.0 X 50.0	1100.0	7.0 X 15.5	108.5
Glass Washing Room	12.0 X 20.0	240.0	3.5 X 6.0	21.0
Balance Room	9.0 X 10.0	90.0	3.0 X 3.0	9.0
Chemical Storage Organic Lab	9.0 X 8.0	72.0	3.0 X 2.5	7.5
Org. Instrument #1	21.0 X 22.0	462.0	6.5 X 7.0	45.5
Org. Instrument #2	20.0 X 22.0	440.0	6.0 X 7.0	45.5
Organic Lab	28.0 X 41.0	1148.0	8.5 X 12.5	106.25
Minimum Land Size Requirement[5]:	150.0 X 110.0	16,500.0	46.0 X 34.0	1,564.0
Recommended Land Size:	200.0 X 150.0	30,000.0	61.0 X 46.0	2,806.0

1. Ft = Feet
2. SF = Square Feet
3. M = Meter
4. SM = Square Meter
5. The land size is estimated usable space plus the width of the corridors. It excludes the structural un-usable space such as wall thickness, beams, and columns.

Table 2
(Design B)

LOCATION	ESTIMATED SIZE (Ft)[1]	ESTIMATED AREA (SF)[2]	ESTIMATED SIZE (M)[3]	ESTIMATED AREA (SM)[4]
Corridor A:				
Reception Area	14.0 X 14.0	196.0	4.5 X 4.5	20.25
Office #1	8.0 X 9.0	72.0	2.5 X 3.0	7.5
Office #2	8.0 X 9.0	72.0	2.5 X 3.0	7.5
Office #3	8.0 X 9.0	72.0	2.5 X 3.0	7.5
Office #4	8.0 X 9.0	72.0	2.5 X 3.0	7.5
Office #5	8.0 X 9.0	72.0	2.5 X 3.0	7.5
Office #6	12.0 X 14.0	168.0	3.5 X 4.5	15.75
Conference Room	20.0 X 11.0	220.0	6.0 X 3.5	21.0
Office #7	7.0 X 11.0	77.0	2.0 X 3.5	7.0
Office #8	7.0 X 11.0	77.0	2.0 X 3.5	7.0
Office #9	7.0 X 11.0	77.0	2.0 X 3.5	7.0
Group Tea/Lunch Room	20.0 X 11.0	220.0	6.0 X 3.5	21.0
Copy Room	14.0 X 25.0	350.0	4.5 X 7.5	33.75
Computer/Staff Room	12.0 X 25.0	300.0	3.5 X 7.5	26.25
Archive	12.0 X 25.0	144.0	3.5 X 7.5	26.75
Janitor Room	10.0 X 14.0	140.0	3.0 X 4.5	13.5
Female Restroom	13.0 X 14.0	182.0	4.0 X 4.5	18.0
Male Restroom	12.0 X 14.0	168.0	3.5 X 4.5	15.75
Utility room	10.0 X 14.0	140.0	3.0 X 4.5	13.5
Corridor B:				
Counting Room #1	36.0 X 25.0	900.0	11.0 X 8.0	88.0
Office #10	8.0 X 9.0	72.0	2.5 X 3.0	7.5
Counting Room #2	22.0 X 25.0	550.0	7.0 X 8.0	56.0
Radiochem. Lab	35.0 X 22.0	770.0	10.5 X 7.0	73.5
Radium Lab	12.0 X 22.0	264.0	3.5 X 7.0	24.5
Rad. Std./QC Room	9.0 X 22.0	198.0	3.0 X 7.0	21.0
O-16 Instrument Room	8.0 X 22.0	176.0	2.5 X 7.0	17.5
O-16 Lab	16.0 X 22.0	352.0	5.0 X 7.0	35.0

Table 2 (*continued*)
(Design B)

LOCATION	ESTIMATED SIZE (Ft)[1]	ESTIMATED AREA (SF)[2]	ESTIMATED SIZE (M)[3]	ESTIMATED AREA (SM)[4]
Corridor C:				
Down Loading	25.0 X 14.0	350.0	8.0 X 4.5	36.0
Office #11	9.0 X 8.0	72.0	3.0 X 2.5	7.5
Supply Room	12.0 X 14.0	168.0	3.5 X 4.5	15.75
Reagent Lab	9.0 X 14.0	126.0	3.0 X 4.5	13.5
Sample Storage Room	8.0 X 14.0	112.0	2.5 X 4.5	11.25
Physical Test Lab	10.0 X 14.0	140.0	3.0 X 4.5	13.5
Aqueous sample prep. Lab	26.0 X 14.0	364.0	8.0 X 4.5	36.0
Non-Aqueous sample prep. Lab	20.0 X 14.0	280.0	6.0 X 4.5	27.0
Soil Grinding	6.0 X 14.0	84.0	2.0 X 4.5	9.0
Waste Storage Room	12.0 X 14.0	168.0	3.5 X 4.5	15.75
Microbio. Instrument	8.0 X 14.0	112.0	2.5 X 4.5	11.25
Microbiology Lab	27.0 X 14.0	378.0	8.0 X 4.5	36.0
Inorg. Instrument #1	22.0 X 50.0	1100.0	7.0 X 4.5	33.75
Inorg. Instrument #2	22.0 X 50.0	1100.0	3.5 X 6.0	21.0
Glass Washing Room	12.0 X 20.0	240.0	3.5 X 6.0	21.0
Balance Room	9.0 X 10.0	90.0	3.0 X 3.0	9.0
Chemical Storage Organic Lab	9.0 X 8.0	72.0	3.0 X 2.5	7.5
Org. Instrument #1	21.0 X 22.0	462.0	6.5 X 7.0	45.5
Org. Instrument #2	20.0 X 22.0	440.0	6.0 X 7.0	45.5
Organic Lab	28.0 X 41.0	1148.0	8.5 X 12.5	106.25
Minimum Land Size Requirement[5]:	150.0 X 110.0	16,500.0	46.0 X 34.0	1,564.0
Recommended Land Size:	200.0 X 150.0	30,000.0	61.0 X 46.0	2,806.0

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